

Problem Set #1

Solutions

1. $P_1 V_1 = nRT_1$ $P_2 V_2 = nRT_2$

Divide the equations

$$\frac{P_2 v_2}{P_1 v_1} = \frac{nRT_2}{nRT_1} \Rightarrow \frac{P_2 v_2}{P_1 v_1} = \frac{\cancel{n}T_2}{\cancel{n}T_1}$$

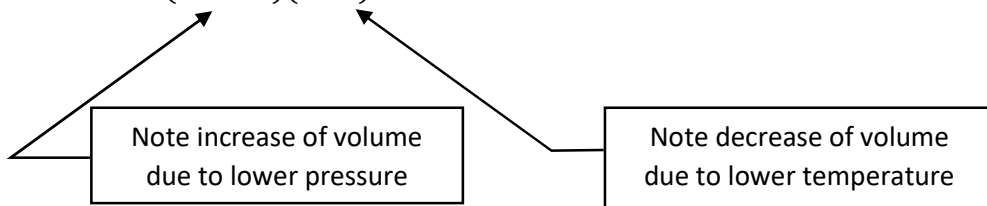
Rearrange:

$$v_2 = v_1 \frac{P_1 T_2}{P_2 T_1}$$

Substituting in values (remember to convert temperature to °R)

$$V_2 = 20 \text{ ft}^3 \frac{(29.91) (460 + 68)}{(29.80) (460 + 235)}$$

$$V = 20 * (1.0037)(0.76)$$



$$V = 15.25 \text{ ft}^3$$

2. From the first problem:

$$V_2 = V_1 \frac{P_1}{P_2}$$

$$V = 20 \text{ L} \frac{29.92}{26.5}$$

$$V = 22.5 \text{ L}$$

$$3. \quad (a) \quad n = \frac{1.6 \text{ lbs}}{M \text{ lb} / \text{lb-mol}}$$

$$M = 2 \times 16 = 32$$

$$n = \frac{1.6}{32} = 0.05 \text{ lb} - \text{moles}$$

(b) assume ice $\text{H}_2\text{O} = 1\text{g H}_2\text{O}$

$$n = \frac{35 \text{ g}}{M \text{ g} / \text{g} - \text{mole}}$$

$$M = (2 \times 1) + 16 = 18$$

$$n = \frac{35}{18} = 1.94 \text{ g} - \text{moles}$$

$$4. \quad (a) \quad v_s = K_p C_p \sqrt{\frac{T_s \Delta P}{P_s M_s}}$$

$$v_s = 85.49 (0.81) \sqrt{\frac{(460 + 286)(1.5)}{\left(29.86 + \frac{1.2}{13.6}\right) 30}}$$

$$v_s = 85.49 (0.81) \sqrt{\frac{(746)(1.5)}{(29.95) 30}}$$

$$v_s = 85.49 (0.81) \sqrt{1.245}$$

$$v_s = 85.49 (0.81) (1.116)$$

$$v_s = 77.28 \text{ ft/sec}$$

5. from 4(a)

$$v_s = 77.28 \frac{0.84}{0.81}$$

$$v_s = 80.14 \text{ ft/sec}$$

Note that if 0.84 is assumed, but the C_p is actually 0.81 as determined in a wind tunnel, the source would report a C_p of 0.81.

$$6. \text{ } pmr = C_s Q_s$$

$$Q_s = (3600 \text{ sec} / \text{ hr}) v_s A_s (1 - B_{ws}) \frac{T_{std} P_s}{P_{std} T_s}$$

$$Q_s = (3600) 77.28 \left[\pi \left(\frac{15}{2} \right)^2 \right] (1 - 0.12) \frac{(460 + 68)}{(29.92)} \frac{(29.95)}{(460 + 286)}$$

$$Q_s = (3600) 77.28 [176.72] (0.88) \frac{(528)}{(29.92)} \frac{(29.95)}{(746)}$$

$$Q_s = 30,652,671 \text{ ft}^3 / \text{ hr}$$

$$pmr = (0.70)(30,652,671)$$

$$pmr = 21,456,870 \text{ gr} / \text{ hr}$$

$$pmr = \frac{21,456,870 \text{ gr} / \text{ hr}}{7000 \text{ gr} / \text{ lb}} = 3056.29 \text{ lb} / \text{ hr}$$

$$pmr = \frac{23056.29 \text{ lb} / \text{ hr}}{2000 \text{ lb} / \text{ Ton}} = 1.533 \text{ tons} / \text{ hr}$$

$$1.533 \text{ tons} / \text{ hr} \times 24 \text{ hr} / \text{ day} \times 365 \text{ days} / \text{ yr} = 13,426 \text{ Tons} / \text{ yr}$$